

REMARKS

The Office Action mailed July 21, 2003, has been received and reviewed. Claims 1 through 26, 72 through 82, and 84 through 106 are currently pending in the application. Claims 1 through 26, 72 through 82 and 84 through 106 stand rejected. Applicant has amended claims herein. Reconsideration is respectfully requested.

Information Disclosure Statement(s)

Applicant notes the filing of an Information Disclosure Statement herein on February 11, 2003 and notes that no copy of the PTO/SB/08 was returned with the outstanding Office Action. Applicant respectfully requests that the information cited on the PTO/SB/08 be made of record herein.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on U.S. Patent No. 6,030,896 to Brown

Claims 1 through 11, 14 through 26, 72 through 82, 84 through 89, and 92 through 106 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Brown (U.S. Patent No. 6,030,896). Applicant respectfully traverses this rejection, as hereinafter set forth.

M.P.E.P. 706.02(j) sets forth the standard for a Section 103(a) rejection:

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, **the prior art reference (or references when combined) must teach or suggest all the claim limitations.** The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). (Emphasis added).

Brown discloses a via formed in a semiconductor device. A first layer of dielectric material 10 is deposited on a semiconductor substrate. A first diffusion barrier layer 12 is formed

on the dielectric material 10 and a layer of copper 14 is formed thereover. An etch stop/second barrier layer 16 is formed over the layer of copper 14 and a second copper layer 18 is formed thereover. A third barrier layer 20 is formed on the second copper layer 18 and the structure is patterned. A thin layer of conductive material 22 is formed over the third barrier layer 20 and etched to expose the third barrier layer 20. (Brown, FIG. 3.) A second dielectric layer 24 is deposited and planarized to expose third barrier layer 20. (Brown FIG. 4.)

By way of contrast with Brown, independent claim 1 of the presently claimed invention recites in part "forming at least one metal containing barrier layer over the first dielectric layer; forming a homogenous conducting layer directly on the at least one metal containing barrier layer; forming a second dielectric layer in contact with the homogenous conducting layer; removing aligned portions of the second dielectric layer, homogenous conducting layer, and at least one metal containing barrier layer to form a multilayer structure; and forming metal containing spacers on sidewalls of the multilayer structure, said metal containing spacers beginning at a lower surface of said at least one metal containing barrier layer and extending substantially to an upper surface of said second dielectric layer."

Applicant respectfully submits that Brown fails to teach or suggest every element of claim 1 of the presently claimed invention. Specifically, Brown fails to teach or suggest "forming a homogenous conducting layer directly on the at least one metal containing barrier layer", "forming a second dielectric layer in contact with the homogenous conducting layer" and "forming metal containing spacers on sidewalls of the multilayer structure, said metal containing spacers beginning at a lower surface of said at least one metal containing barrier layer and extending substantially to an upper surface of said second dielectric layer." Brown teaches forming sidewalls extending from diffusion barrier layer 12 to third barrier layer 20. However, diffusion barrier layer 12 does not have a homogenous conducting layer formed directly thereon that is in contact with a second dielectric layer.

As Brown fails to teach or suggest every element of claim 1 of the presently claimed invention, applicant submits that Brown does not render the presently claimed invention obvious.

Claims 2 through 26 are each allowable as depending, either directly or indirectly, from allowable independent claim 1.

Claim 4 is further allowable as Brown fails to teach or suggest forming a second metal containing barrier layer between a first metal containing barrier layer of said at least one metal containing barrier layer and the substrate, said second metal containing barrier layer comprising TiN, TiW, WN, or TaN.

Claim 8 is further allowable as Brown fails to teach or suggest forming the homogenous conducting layer of an aluminum-copper alloy.

Claim 12 is further allowable as Brown fails to teach or suggest forming the second dielectric layer of a low dielectric constant material.

Claim 13 is further allowable as Brown fails to teach or suggest forming the second dielectric layer of a fluorine-doped silicon oxide.

Claims 15 and 16 are further allowable as Brown fails to teach or suggest forming the at least one metal containing barrier layer by vapor deposition or by CVD, PVD or PECVD.

Claims 17 and 18 are further allowable as Brown fails to teach or suggest the homogenous conducting layer by vapor deposition or by CVD, PVD or PECVD.

Claim 22 is further allowable as Brown fails to teach or suggest forming a metal containing spacer layer over the multilayer structure and first dielectric layer and removing portions thereof overlying the first and second dielectric layers. Instead, Brown teaches forming the conductive barrier material 22 before the second dielectric layer 24. (Brown, paragraph bridging col. 4 and 5; col. 5, lines 5-17.)

Claims 25 and 26 are further allowable as Brown fails to teach or suggest removing any remaining portion of the second dielectric layer and upper portions of the metal containing spacers laterally adjacent thereto to expose said homogenous conducting layer. Instead, Brown discloses planarizing the second dielectric layer 24 and conductive barrier material 22 to expose a barrier metal layer 20.

By way of contrast with Brown, claim 72 of the presently claimed invention recites, in part, "creating a homogenous conducting layer directly over the at least one metal containing barrier layer, said homogenous conducting layer comprising at least copper or aluminum and comprising an upper surface, said upper surface of said homogenous conducting layer out of contact with any metal; removing aligned portions of the homogenous conducting layer and at least one metal containing barrier layer to form a multilayer structure; and flanking at least one surface of the multilayer structure with a metal containing spacer, said metal containing spacer initiating at said at least one metal containing barrier layer and extending to substantially the same height as said homogenous conducting layer."

Applicant respectfully submits that Brown fails to teach or suggest every element of claim 72 of the presently claimed invention. Brown teaches forming sidewalls extending from diffusion barrier layer 12 to third barrier layer 20. However, diffusion barrier layer 12 does not have a homogenous conducting layer formed directly thereon comprising an upper surface out of contact with any metal. Further, Brown fails to teach or suggest flanking the multi-layer structure with sidewalls initiating at said at least one metal containing barrier layer and extending to substantially the same height as said homogenous conducting layer.

As Brown fails to teach or suggest every element of the presently claimed invention, applicant submits that independent claim 72 of the presently claimed invention is not rendered obvious by Brown. Thus, claim 72 is allowable.

Claims 73 through 82 and 84 through 102 are each allowable as depending, either directly or indirectly, from allowable claim 72.

Claims 73 and 74 are further allowable as Brown fails to teach or suggest forming a second dielectric layer in contact with said homogenous conducting layer. Instead, Brown discloses a dielectric layer 24 in contact with conductive barrier spacers 22 or dielectric layer 25 in contact with etch stop layer 16. (Brown, FIG. 4 and 5.)

Claims 75 and 76 are further allowable as Brown fails to teach or suggest forming a metal containing spacer layer on said second dielectric layer and removing any remaining portion of the second dielectric layer and upper portions of the metal containing spacer layer laterally adjacent thereto.

Claim 81 is further allowable as Brown fails to teach or suggest forming a second metal containing barrier layer between a first metal containing barrier layer of the at least one metal containing barrier layer and the substrate, said second metal containing barrier layer comprising TiN, TiW, WN, or TaN.

Claim 84 is further allowable as Brown fails to teach or suggest creating the homogenous conducting layer of an aluminum-copper alloy.

Claim 89 is further allowable as Brown fails to teach or suggest forming a second dielectric layer on the homogenous conducting layer to have sidewalls aligned with the conductive layer sidewalls, and forming the metal containing spacer to extend along the sidewalls of the second dielectric layer. Instead Brown discloses a dielectric layer 24 in contact with conductive barrier spacers 22 or dielectric layer 25 on the etch stop layer 16 and above the conductive barrier spacers 22. (Brown, FIGs. 4 and 5.)

Claim 90 is further allowable as Brown fails to teach or suggest forming the second dielectric layer of a low dielectric constant material.

Claim 91 is further allowable as Brown fails to teach or suggest forming the second dielectric layer of a fluorine-doped silicon oxide.

Claim 93 is further allowable as Brown fails to teach or suggest forming the at least one metal containing barrier layer by vapor deposition.

Claim 94 is further allowable as Brown fails to teach or suggest forming the at least one metal containing barrier layer by CVD, PVD or PECVD.

Claim 95 is further allowable as Brown fails to teach or suggest forming the homogenous conducting layer by vapor deposition.

Claim 96 is further allowable as Brown fails to teach or suggest forming the homogenous conducting layer by CVD, PVD or PECVD.

Claim 100 is further allowable as Brown fails to teach or suggest that flanking comprises forming the metal containing spacer by forming a metal containing spacer layer over the multilayer structure and first dielectric layer and removing portions thereof overlying the first dielectric layer and a top portion of said multilayer structure.

Independent claim 103 is allowable for substantially the same reasons as allowable claim 1. Claim 103 recites, in part, "forming a homogenous conducting layer directly on the at least one metal containing barrier layer; forming a second dielectric layer in contact with the homogenous conducting layer; removing aligned portions of the second dielectric layer, the homogenous conducting layer, and the at least one metal containing barrier layer to form a multilayer structure; forming metal containing spacers on sidewalls of the multilayer structure, said metal containing spacers originating at said at least one metal containing barrier layer; and removing any remaining portion of the second dielectric layer and upper portions of the metal containing spacers laterally adjacent thereto."

Applicant respectfully submits that Brown fails to teach or suggest every element of claim 103 of the presently claimed invention. Brown teaches sidewalls originating at diffusion barrier layer 12 and extending to third barrier layer 20. Diffusion barrier layer 12 does not have a homogenous conducting layer formed directly thereon that is in contact with a second dielectric layer.

Accordingly, as Brown fails to teach or suggest every element of claim 103 of the presently claimed invention, applicant submits that Brown does not render the presently claimed invention obvious.

Claim 104 is allowable as depending from allowable claim 103 of the presently claimed invention.

By way of contrast with Brown, amended claim 105 of the presently claimed invention recites, in part, "creating a homogenous conducting layer directly on the at least one metal containing barrier layer; forming a second dielectric layer on said homogenous conducting layer; removing aligned portions of the second dielectric layer, the homogenous conducting layer and the at least one metal containing barrier layer to form a multilayer structure; flanking at least one

surface of the multilayer structure with a metal containing spacer such that said metal containing spacer originates at said at least one metal containing barrier and is substantially the same height as said second dielectric layer; and removing any remaining portion of the second dielectric layer and upper portions of the metal containing spacer layer laterally adjacent thereto.”

Applicant respectfully submits that Brown fails to teach or suggest every element of claim 105 of the presently claimed invention. Instead, Brown teaches sidewalls originating at diffusion barrier layer 12 and extending to third barrier layer 20. Brown fails to teach or suggest forming a diffusion barrier layer 12 having a homogenous conducting layer formed directly thereon that is in contact with a second dielectric layer.

Accordingly, as Brown fails to teach or suggest every element of claim 105 of the presently claimed invention, applicant submits that Brown does not render the presently claimed invention obvious.

Claim 106 is allowable as depending from allowable claim 105.

Obviousness Rejection Based on U.S. Patent No. 6,030,896 to Brown in View of U.S. Patent No. 6,277,745 to Liu et al.

Claims 12, 13, 90, and 91 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Brown (U.S. Patent No. 6,030,896) in view of Liu et al. (U.S. Patent No. 6,277,745). Applicant respectfully traverses this rejection, as hereinafter set forth.

The discussion of Brown is incorporated herein. Liu discloses a passivation method of post copper dry etching. Liu discloses a sandwich structure consisting of a bottom barrier layer 4, a copper layer 6 and a top barrier metal layer 8. After formation of this sandwich structure and patterning, the exposed sidewalls are passivated by means of a barrier metal spacer process. Liu teaches that the fully encapsulated copper lines are highly resistant to oxidation which is an otherwise inherent problem with bare copper lines. (Liu, Abstract.)

The Court of Appeals for the Federal Circuit has stated that “dependent claims are nonobvious under section 103 if the independent claims from which they depend are nonobvious.” In re Fine, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988). See also MPEP § 2143.03.

Having failed to teach or suggest each and every limitation of the current application, the prior art referenced as rendering dependent claim 12, 13, 90, and 91 obvious, cannot serve as a basis for rejection.

Obviousness Rejection Based on U.S. Patent No. 6,277,745 to Liu et al.

Claims 1, 11 through 13, 72 through 75, and 88 through 91 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Liu et al. (U.S. Patent No. 6,277,745). Applicant respectfully traverses this rejection, as hereinafter set forth.

Liu discloses a passivation method of post copper dry etching. Liu discloses a sandwich structure consisting of a bottom barrier layer 4, a copper layer 6 and a top barrier metal layer 8. After formation of this sandwich structure and patterning, the exposed sidewalls are passivated by means of a barrier metal spacer process. Liu teaches that the fully encapsulated copper lines are highly resistant to oxidation which is an otherwise inherent problem with bare copper lines. (Liu, Abstract.)

By way of contrast with Liu, independent claim 1 of the presently claimed invention recites in part “forming at least one metal containing barrier layer over the first dielectric layer; forming a homogenous conducting layer directly on the at least one metal containing barrier layer; forming a second dielectric layer in contact with the homogenous conducting layer; removing aligned portions of the second dielectric layer, homogenous conducting layer, and at least one metal containing barrier layer to form a multilayer structure; and forming metal containing spacers on sidewalls of the multilayer structure, said metal containing spacers beginning at a lower surface of said at least one metal containing barrier layer and extending substantially to an upper surface of said second dielectric layer.”

Applicant respectfully submits that Liu fails to teach or suggest every element of claim 1 of the presently claimed invention. Specifically, Liu fails to teach or suggest “forming a homogenous conducting layer directly on the at least one metal containing barrier layer”, and

“forming a second dielectric layer in contact with the homogenous conducting layer”. Instead, Liu teaches forming sidewalls beginning at barrier layer 4 and extending to cap 16. Copper layer 6 is formed on barrier layer 4, but copper layer 6 is not in contact with a second dielectric layer.

As Liu fails to teach or suggest every element of independent claim 1, claim 1 of the presently claimed invention is allowable.

Claims 2 through 26 are each allowable as depending, either directly or indirectly, from allowable claim 1.

Claim 11 is further allowable as Liu fails to teach or suggest forming the second dielectric layer on the homogenous conducting layer to have sidewalls aligned with sidewalls of the homogenous conducting layer, and forming the metal containing spacers to extend along the sidewalls of the second dielectric layer. Instead, Liu teaches forming metal barrier layer 8 on copper layer 6 and a hard mask layer 16 over a second barrier metal layer 8.

By way of contrast with Liu, independent claim 72 of the presently claimed invention recites, in part, “creating a homogenous conducting layer directly over the at least one metal containing barrier layer, said homogenous conducting layer comprising at least copper or aluminum and comprising an upper surface, said upper surface of said homogenous conducting layer out of contact with any metal; removing aligned portions of the homogenous conducting layer and at least one metal containing barrier layer to form a multilayer structure; and flanking at least one surface of the multilayer structure with a metal containing spacer, said metal containing spacer initiating at said at least one metal containing barrier layer and extending to substantially the same height as said homogenous conducting layer.”

Applicant respectfully submits that Liu fails to teach or suggest every element of claim 72 of the presently claimed invention. Specifically, Liu fails to teach or suggest “creating a homogenous conducting layer directly over the at least one metal containing barrier layer, said homogenous conducting layer comprising at least copper or aluminum and comprising an upper surface, said upper surface of said homogenous conducting layer out of contact with any metal.” Liu teaches flanking a multi-layer structure with sidewalls initiating at barrier layer 4 and

extending beyond copper layer 6 formed on barrier layer 4. Additionally, upper surface of copper layer 6 is in contact with metal layer 8.

As Liu fails to teach or suggest every element of independent claim 72, claim 72 of the presently claimed invention is allowable.

Claims 73 through 102 are each allowable as depending, either directly or indirectly, from allowable claim 72.

Claim 73 is further allowable as Liu fails to teach or suggest forming a second dielectric layer in contact with said homogenous conducting layer. Instead, Liu teaches forming second barrier metal layer 8 over copper layer and a hard mask layer 16 over a second barrier metal layer 8.

Claim 89 is further allowable as Liu fails to teach or suggest forming the second dielectric layer on the homogenous conducting layer to have sidewalls aligned with sidewalls of the homogenous conducting layer, and forming the metal containing spacers to extend along the sidewalls of the second dielectric layer. Instead, Liu teaches forming metal layer 8 on copper layer 6 and a hard mask layer 16 over a second barrier metal layer 8.

Obviousness Rejection Based on U.S. Patent No. 6,074,943 to Brennan et al.

Claims 1 through 12 and 14 through 24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Brennan et al. (U.S. Patent No. 6,074,943). Applicant respectfully traverses this rejection, as hereinafter set forth.

Brennan teaches a method of forming via structures using sidewalls as guides. Thus, as shown in FIGS. 2A-2H, Brennan teaches an Al-Cu layer 210 overlying an oxide layer 200 and an optional TiN barrier layer 205. A layer of anti-reflective coating (TiN) 215 is deposited on the Al-Cu layer 210. A layer of sidewall material 240 is deposited (FIG. 2E) and etched to an etch stop layer 220. The etch stop layer 220 is removed and a dielectric material 250 is deposited

over the structure in contact with and sidewalls 240. (FIG. 2G.) Brennan teaches that after the dielectric material 250 deposition is complete, "the sidewall material 240 will jut up into the ILD 250, forming sidewall extensions 260." (Brennan, col. 2, lines 64-66.) Subsequently, vias 270 are etched in the ILD layer 250 to contact the underlying interconnect. (FIG. 2H.)

By way of contrast with Brown, independent claim 1 of the presently claimed invention recites in part "forming at least one metal containing barrier layer over the first dielectric layer; forming a homogenous conducting layer directly on the at least one metal containing barrier layer; forming a second dielectric layer in contact with the homogenous conducting layer; removing aligned portions of the second dielectric layer, homogenous conducting layer, and at least one metal containing barrier layer to form a multilayer structure; and forming metal containing spacers on sidewalls of the multilayer structure, said metal containing spacers beginning at a lower surface of said at least one metal containing barrier layer and extending substantially to an upper surface of said second dielectric layer."

Applicant respectfully submits that Brennan fails to teach or suggest every element of claim 1 of the presently claimed invention.

Specifically, Brennan fails to teach or suggest "forming a homogenous conducting layer directly on the at least one metal containing barrier layer", "forming a second dielectric layer in contact with the homogenous conducting layer" and "forming metal containing spacers on sidewalls of the multilayer structure, said metal containing spacers beginning at a lower surface of said at least one metal containing barrier layer and extending substantially to an upper surface of said second dielectric layer." Instead, Brennan teaches forming sidewalls beginning at metal barrier layer 205 and extending to mask layer 220 or beyond reflective coating layer 215. Brennan further teaches forming conducting layer 210 directly on metal barrier layer 205. But, second dielectric layer 250 is not in contact with conducting layer 210 and Brennan fails to teach or suggest forming spacers extending substantially to an upper surface of a second dielectric layer.

As Brennan fails to teach or suggest every element of claim 1 of the presently claimed invention, applicant respectfully submits that claim 1 is not rendered obvious by Brennan.

Accordingly, claim 1 is allowable.

Claims 2 through 26 are each allowable as depending, either directly or indirectly from allowable claim 1.

Claim 2 is further allowable as Brennan fails to teach or suggest forming a silicon oxide or BPSG layer.

Claim 11 is further allowable as Brennan fails to teach or suggest forming a second dielectric layer comprises forming the second dielectric layer on the homogenous conducting layer to have sidewalls aligned with sidewalls of the homogenous conducting layer, and forming the metal containing spacers to extend along the sidewalls of the second dielectric layer.

Claim 15 is further allowable as Brennan fails to teach or suggest forming the at least one metal containing barrier layer comprises forming the at least one metal containing barrier layer by vapor deposition.

Claim 16 is further allowable as Brennan fails to teach or suggest forming the at least one metal containing barrier layer comprises forming the at least one metal containing barrier layer by CVD, PVD or PECVD.

Claim 17 is further allowable as Brennan fails to teach or suggest forming the homogenous conducting layer comprises forming the homogenous conducting layer by vapor deposition.

Claim 18 is further allowable as Brennan fails to teach or suggest forming the homogenous conducting layer by CVD, PVD or PECVD.

Claim 22 is further allowable as Brennan fails to teach or suggest forming the metal containing spacers comprises forming a metal containing spacer layer over the multilayer structure and first dielectric layer and removing portions thereof overlying the first and second dielectric layers.

ENTRY OF AMENDMENTS

The amendments to the claims above should be entered by the Examiner because the amendments are supported by the as-filed specification, for example, paragraph [0034], and drawings and do not add any new matter to the application.

CONCLUSION

Claims 1 through 26, 72 through 82, and 84 through 106 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, he is respectfully invited to contact Applicant's undersigned attorney.

Respectfully submitted,



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